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THESIS

MANAGEMENT CONCERNS FOR OPTICAL BASED FILING SYSTEMS

by

Joseph F. Rodriguez

March 1990

Thesis Advisor: Barry A. Frew

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The use of optical technology has been assessed as the next step in the storage of information. Optical imaging systems for paper management have the potential benefits of improving productivity and permitting access to information on paper quickly.

Although optical media is a relatively new technology there are many articles addressing the uses for optical media. With the exception of compact disks, optical disks have not gained rapid acceptance even though the market potential due to the storage capabilities of optical disks is much greater than standard magnetic media.

One aspect about optical systems that does not receive much attention is how organizations should introduce optical media filing systems in their organizations. Speed, compatibility with current systems, paper administration, legal issues and strategic planning are just a few of the issues that have to be addressed. This thesis investigated management concerns which must be addressed when considering document imaging systems.

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Management Concerns for Optical Based Filing Systems

by

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Lieutenant, United States Coast Guard
B.S., United States Coast Guard Academy, 1980

Submitted in partial fulfillment of the requirements for
the degree of

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from the

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ABSTRACT

The use of optical technology has been assessed as the next step in the storage of information. Optical imaging systems for paper management have the potential benefits of improving productivity and permitting access to information on paper quickly.

Although optical media is a relatively new technology there are many articles addressing the uses for optical media. With the exception of compact disks, optical disks have not gained rapid acceptance even though the market potential due to the storage capabilities of optical disks is much greater than standard magnetic media.

One aspect about optical systems that does not receive much attention is how organizations should introduce optical media filing systems in their organizations. Speed, compatibility with current systems, paper administration, legal issues and strategic planning are just a few of the issues that have to be addressed. This thesis investigated management concerns which must be addressed when considering document imaging systems.

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I. INTRODUCTION

A. DISCUSSION

Corporations have been using computers for many requirements in their business. Engineering firms are using them to help design everything from parts to buildings. Auto makers use them to design new car models and even build the cars using robotics. The financial industry uses them to manage millions of investment dollars. The insurance industry uses them to determine premiums and to maintain case files of customers. Both Federal and State governments are using them to help manage daily operations.

While uses may be different a common thread is the use of paper. Although computers can manage millions of bits of information the one thing that continues to hamper the overall performance of businesses is the need for paper. For corporations, Federal, State, and Local governments this is a crisis that needs to be addressed. Case files that include information on business objectives and customer data continue to be maintained in ever popular manila folders stored in equally popular metal filing cabinets. It is not uncommon for a customer file to be active for 20 to 30 years or longer. The requirement to access this information has not diminished by using computers.

Organizations have attempted to address this problem with many different solutions. Color coding files is popular but this becomes

unwieldy when thousands are involved. Sliding shelves or conveyor belt systems such as a Lektriever system to access records was an early attempt to manage the volume of files. These systems have a number of drawbacks the least of which is being slow, the difficulty encountered in finding the correct file, the high probability of misfiling or losing records and the physical space required to store thousands of records.

Converting paper records to microfiche was another attempt at speeding up the process and reducing the space required for storage. Microfiche has similar problems to previous filing systems in that files must still be retrieved and a single record must still be searched for individually. More records can be stored on a roll of microfiche but records may still be misfiled or lost.

B. IMAGING SYSTEMS

The next generation of storage has now evolved into the use of optical media. Terms such as Optical Character Recognition (OCR), Write Once-Read Many (WORM), Erasable Optical (EO) and Compact Disk - Read Only Memory (CD-ROM) are just a few that have caught the ear and eye of the Information Manager.

The use of optical technology has been assessed as the next step in the storage of information. Optical technology has been around since the 1940's but the first commercial breakthrough did not come until the early 70's when N.V. Phillips developed the first optical disk. Spurred by involvement of the U.S. Government, the media

evolved rapidly to the point that most IS managers have seen or heard about video and audio compact disks.

Organizations have found many different uses for optical media filing systems. The Tampa Electric Company utilizes the TAB Laser-Optic Filing System (LOFS) for the maintenance of their personnel records. LOFS replaced a Lektriever mobile filing system which allowed the utility to free up space and money as the old system was difficult to use and constantly breaking down. Sensitive information previously difficult to control in the old system is more readily controlled as only a few key people now have access to the information.

Another firm, Central Iowa Power Cooperative (CIPCO) uses the TAB system to better manage the 15 rural cooperatives it does business with. At CIPCO a problem existed because both executives and secretaries were filing documents under different indexes. The uniform indexing under LOFS made accessing files more efficient.

The United States Automobile Association (USAA) has been judged as one of the most ambitious users of Imaging Systems. USAA is an insuring agent that relies on agents located in San Antonio, Texas, to deal with customers by phone as opposed to having agents scattered all over the United States. USAA began looking at image processing in 1969 when the CEO directed the company to become a paperless office. USAA started to actively pursue imaging as a solution in 1982, with a prototype system coming on line in 1984. The prototype led to the IBM Imageplus

System based on their 4381 mainframe. The system supports 1300 end users with a goal of 2000. Approximately 25,000 pieces of paper are being scanned and stored daily. The paper is discarded. Their manual paper system required 39,000 square feet of space, roughly the size of a football field, whereas scanned images stored on disk need only 100 square feet. The image system now allows a customer to contact any agent without concern that their file will be sitting on someone else's desk. [Ref. 1]

Image systems have not been without problems. The State of California contracted with FileNet Corp. to convert property-lien records from a mainframe-based, time sharing system to an on line optical search and retrieval (OSAR) system. The attempt to streamline the loan system backfired and the state had to spend $500,000 to rectify the situation. The system failed because FileNet was not allowed adequate parallel operation time for debugging the system.

Although optical media is a relatively new technology there are many articles addressing the uses for optical media. With the exception of compact disks, optical disks have not gained rapid acceptance even though the market potential due to the storage capabilities of optical disks is much greater than standard magnetic media. However, one aspect about optical systems that does not receive much attention in current literature is how organizations should introduce optical media filing systems in their organizations. Speed, compatibility with current systems, paper administration,

legal issues and strategic planning are just a few of the issues that have to be addressed.

C. THESIS ORGANIZATION

To understand the issues involved in integrating optical media filing technologies, it is necessary to understand the technology itself, how optical media is being used and the problems associated with optical media filing systems. A brief analysis of a potential use by the U.S. Coast Guard, Office of Personnel, for the storage of military service records will be used as an example of the issues to be addressed. The final section includes conclusions and recommendations.

II. OPTICAL MEDIA TECHNOLOGY

A. INTRODUCTION

Due to the large storage requirements for digital information, existing magnetic storage media is considered inadequate for the storage and maintenance of large image databases. Optical disk provides a low cost, highly accurate method for storing large volumes of information, including images, in a relatively compact space. Incorporating disk changers (juke box) into a system can allow 100 or more optical disks to be accessed on line. With the use of juke box changers, gigabytes of information are readily accessible in a document imaging system. A brief description of methodologies for storing data on optical disks is described for the reader's benefit.

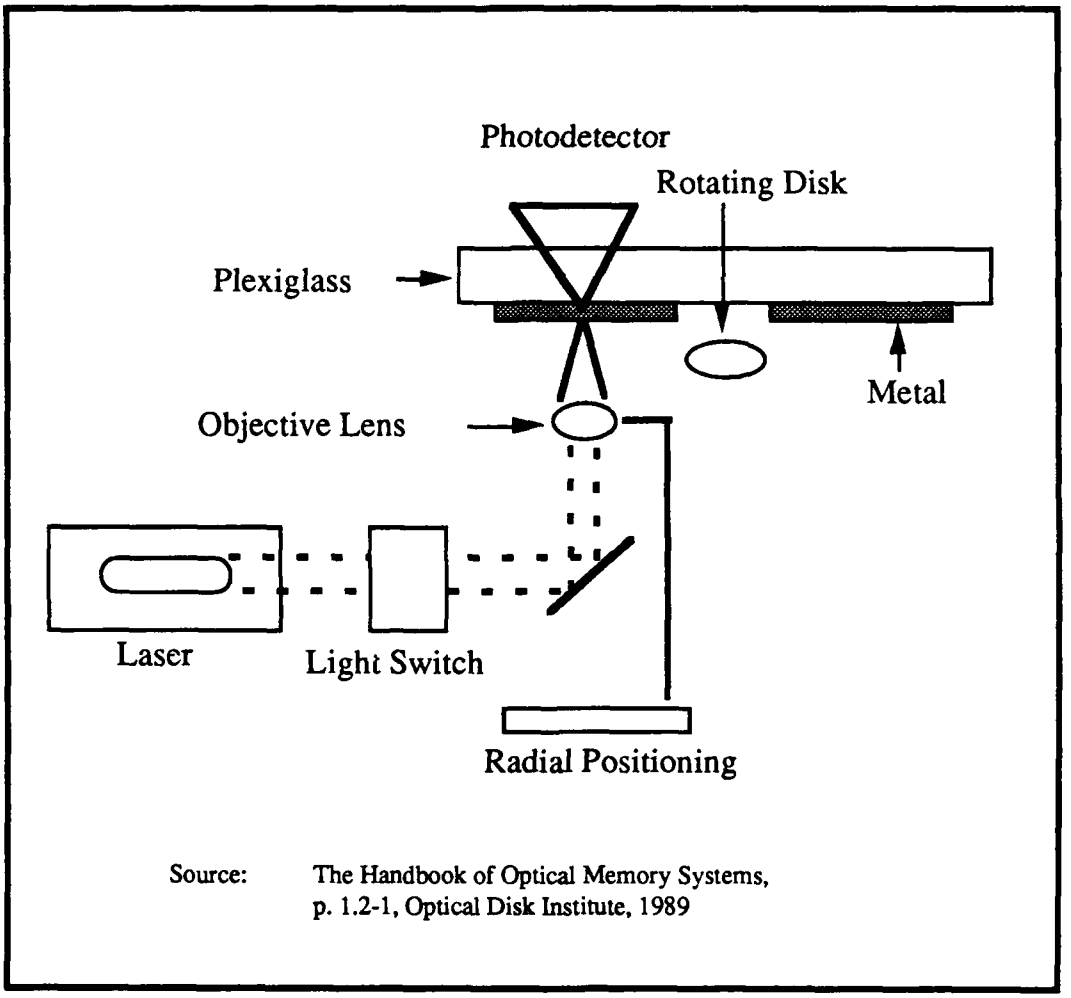
B. RECORDING METHODS

1. Ablative Recording

This method involves the use of a laser, focused through an objective lens onto a laser sensitive recording material such as tellurium, strengthened with other compounds or reflective aluminum.

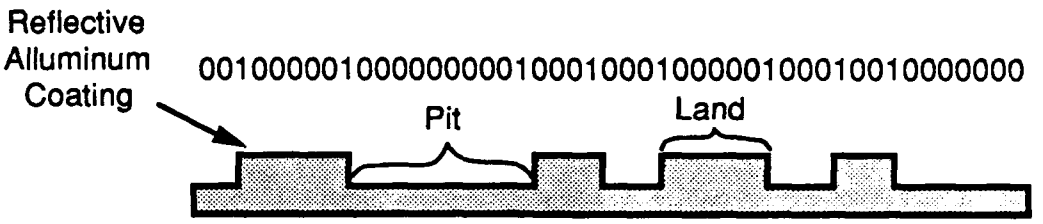
The laser burns a pit into the laser sensitive layer creating pits and lands. The pits are recorded as zeros with the lands recorded as one's. The same laser, operated at a lower intensity, reads the presence or absence of the pits and converts them to

binary code. Figures 1 and 2 show a simplified diagram of an optical recording system and the effect of the laser on the recording material in creating the pits and lands. [Ref. 2]



Source: The Handbook of Optical Memory Systems, p. 1.2-1, Optical Disk Institute, 1989

Figure 1. Optical Disk Recording Systems



Pit: microscopic depression in the reflective surface.

Land: raised and reflective surface between two adjacent pits.

Binary 1: the transition from pit to land and land to pit.

Source: USE OF OPTICAL STORAGE DEVICES AS SHARED RESOURCES IN LOCAL AREA NETWORKS, Master's Thesis by James C. Hoge, Naval Postgraduate School, Monterey, California, p. 54, September 1989

Figure 2. Physical Construction on Optical Disk

2. Thermal-Bubble Recording

This process is similar to the ablative method, except that a bubble is created when the laser is focused on the recording material instead of a pit. The changes in the reflectivity of the bubbles are converted to binary code for the computer. [Ref. 2]

3. Amorphous/Crystalline Recording

In this method, the laser sensitive material is altered from an amorphous (non-reflective) to a crystalline (reflective) state. No pits or bubbles are made on the disk. The laser of the disk drive can recognize where the reflectivity of the material has changed and can

convert it to binary code. Manufacturers have made claims that this method is more stable than the ablative or bubble method and will last longer. [Ref. 2]

4. Erasable Optical

This technology is similar to magnetic media in that the information is erasable. The medium consists of metals with certain magnetic properties which can be changed when the metal is heated.

Erasable optical is similar to the optical technologies in that a laser is used to heat the recording area. The laser allows the polarity of the medium to be changed to represent either a "0" or a "1" depending on its magnetic field. The recorded area can be erased by heating the area with a more powerful laser to allow the reversing of the polarity. [Ref. 3]

With regard to the issue of erasability, it is the same as magnetic technology with the drawback that it is currently much slower than standard magnetic drives. Where access times of Winchester drives can be measured in the teens of milliseconds, erasable optical drives are estimated at access rates of about 60 milliseconds.

C. SUMMARY

The previous sections discussed the method by which binary data are recorded on various optical media. In discussing optical filing systems it is not necessary to discuss the method that is employed, simply that they exist. The various recording methods have been

combined to create systems that are capable of storing millions of bytes of information which is necessary when employing optical filing systems. Future sections will discuss the components in these systems and their capabilities.

III. OPTICAL MEDIA FILING SYSTEMS

A. INTRODUCTION

Optical media filing systems are being heralded as the technology for organizations to gain control of their paper management problems as well as provide a competitive edge. Although government agencies are not in a competitive business, shrinking work forces and budgets as well as growing information requirements are driving them toward these systems.

Using optical technology allows the integration of computer based organization information with the information that is presently being maintained in manila folders and file drawer systems mentioned earlier.

Image systems can be divided into three categories by their size. High volume systems, such as previously described at USAA, have been categorized as those that service 100 or more users, can store 1 million pages on-line, and generally cost more than $1 million. Mid-volume systems usually cost from $100,000 to $300,000 and use a small network of workstations. The low-end standalone approach usually involves PC's or proprietary workstations for single users such as the TAB system. [Ref. 1]

Many options exist for the integration of document based systems with optical based systems. In general, all systems have the same basic components. This section will describe the various components

and aspects that need to be considered when applying them to current systems.

B. SYSTEM COMPONENTS

Most optical filing systems consist of four basic components. An image capture component necessary to convert the paper document to a form that is readable by computer; an optical storage component large enough to store many captured images; an image transmission and computer component that utilizes indexing software to retrieve selected images; and an image presentation component that allows the image to be viewed on a computer terminal or back in paper form. The following sections will introduce each of the components and provide some of the options that are available when building a total system.

1. Image Capture

Presently the method utilized for the conversion of paper documents to computer readable form are microfiche and optical scanners. Microfiche does not provide a true computer readable media and has many of the drawbacks associated with manila folders and filing cabinets. As such, it will not be discussed further in this thesis.

In scanning information from a document, two different methods exist. The first is image scanning which captures the document as an image. The second method scans just the text using optical character recognition (OCR) or intelligent character recognition

(ICR). [Ref. 2] For purposes of this thesis, the two methods OCR and ICR text scanners will be combined as ICR scanners.

a. Image Scanning

Image scanning consists of a charge coupled device (CCD), a light sensitive semiconductor, which produces an electrical charge on its surface proportional to the light incident on it [Ref. 2]. Because the ink that comprises the text or any graphics, absorbs the light and the white paper reflects the light, the different areas can be distinguished from each other. This thesis will not discuss the technical aspects of this process, only the fact that it is a method that exists.

One factor that is very important in the scanning process is the resolution quality. The resolution quality determines how many pixels, or dots per inch (dpi), are distinguishable by the scanner. In document filing systems 200 dpi is usually an acceptable amount but many systems use 300 dpi for cleaner, crisper resolution. The deciding factor is usually the type of documents that will be scanned. Smaller print and elaborate graphics require a higher resolution.

Scanners can be designed to measure the degree of lightness or darkness for each pixel and assign it a numerical value of either "1" or "0". Systems can be designed to recognize gray scale, since images may not be simply black or white. Up to 256 different levels of gray can be detected. Depending on the documents scanned, eight levels of gray scale are usually adequate. Eight levels would

require three binary bits to represent each pixel. Table 1 shows the impact of higher resolution on storage requirements in bits of a standard 8 1/2" x 11" scanned document.

Table 1. Storage Requirements

Resolution (dpi)	Storage Requirement (1 bit)	Storage Requirement (3 bits)
50	233,750	701,250
100	935,000	2,805,000
200	3,740,000	11,220,000
300	8,415,000	25,245,000

The storage requirement for one document would preclude even the use of optical memory systems if some method did not exist to manage the size of a scanned document. Data compression techniques, such as CCITT Group 3 or Group 4, allow the scanner to compress the data before it is stored on disk. Data compression ratios of 5:1 to 80:1 are possible but 10:1 is average. The compression rate is also dependent on the document being scanned. The more white space that a document contains the higher the compression rate.

Flat bed scanner systems require the document to be placed on a glass plate and the CCD is moved across the document. This type of scanner is used most frequently when the paper in question is going to be stored as an image and particular information

on it will not be accessed independently. Other scanners have fixed CCD's and the paper is moved across the light source. This method is most commonly used in ICR applications.

b. Intelligent Character Recognition

Intelligent character recognition (ICR) scanners digitize characters one line at a time and then isolate them, character by character, into frames. The individual frames are stored for character recognition processing [Ref. 4]. The scanner uses either Matrix Matching or Feature Extraction[1]. Both methods essentially compare the frames in question with images of known characters to determine what character has been scanned. The problem with both methods is that complete sets of templates for each font that may be scanned must be maintained in a font library. The number of fonts that are available makes either methodology very unreliable when the number of documents with different fonts is large.

Minor variations in fonts may not be distinguishable by the scanner. Even if the font is in the library, if the original document was of poor quality the scanner may not be able to recognize the font, causing many characters to go unrecognized. In any system the task of cleaning up such a document is very costly and time consuming.

If documents contain a graphic, such as a company logo or a person's signature, an OCR scanner has no way of recognizing it.

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[1]Reference 4 discusses in greater detail the theory behind the two methods of character recognition.

This creates an anomaly. A true document filing system must allow for the easy capture of both graphics and characters as this is invariably what is contained in paper files being eliminated.

2. Optical Storage Components

Storing the image on optical disks has been described previously. This section describes different media that are available for document imaging systems.

a. CD-ROM

CD-ROM is used most effectively in systems that require access to information that is non-changing or less changing in nature such as reference books. Table 2 outlines the amount of information that can be stored on a single CD-ROM disk.

CD-ROM vendors have agreed on and implemented format standards. The High Sierra Group, a group including DEC, Apple, Hewlett-Packard, Phillips, Sony, and the National Information Standards Organization (NISO), were responsible for developing a formal standard that later became the ISO 9660 standard. The ISO 9660 standard allows any conforming CD-ROM disk to be mounted and read by any conforming drive. These standards have provided world-wide compatibility of CD-ROM applications. [Ref. 5]

Table 2. CD-ROM Storage Capabilities

- 270,000 pages of text or,
- 20,000 pages of images scanned at 300 dpi or,
- 10,000 pages comprised of 1/2 text and 1/2 Graphics or,
- 1,500 5 1/4" floppy disks or,
- 1200 microfiche cards or,
- 27 20MB winchester disks.

Source: OPTICAL LASER TECHNOLOGY, SPECIFICALLY CD-ROM, AND ITS APPLICATION TO THE STORAGE AND RETRIEVAL OF INFORMATION, MASTER'S Thesis by David J. Lind, Naval Postgraduate School, Monterey, California, pg. 24, June 1987

b. WORM

WORM technology is the methodology of choice for document filing systems. Since the documents can be scanned, and the stored images are not changeable but are appendable, the paper can be discarded. As in CD-ROM, WORM drives provide the capability of storing gigabytes of information. Although the data is not modifiable, software is added as part of the WORM drive to make it appear to the user that the information has, in fact, been changed. The old data is still on the disk but to the user it is no longer accessible. This feature is one of the most desirable to the industry since the old data is always available and can be used in legal issues. [Ref. 6]

Two characteristics are presently hampering the total acceptance of WORM drives, both of which are technology related and will probably be resolved as the technology matures. The first is

that WORM drive manufacturers have not accepted a format standard. A WORM disk from one manufacturer can not necessarily be used in a drive by another manufacturer once it is formatted. The second characteristic is its slow access speed compared to Winchester drives. However, if you compare the access speed of a person going to a file drawer to obtain a document to that of WORM drive accessing that same document it is very fast. Table 3 provides a list of features for various WORM manufacturers.

c. Erasable Optical

Erasable optical is often used for document filing systems because of its high storage capacity. A disadvantage of this form of optical technology is that stored data can be modified just as in magnetic media. If the objective of the system is to discard the original paper, the ability to erase the image is an undesirable feature. Since the information can be erased, often with no trace, erasable optical storage devices do not lend themselves to document filing systems because the original paper will still have to be retained for legal and business objectives. Table 4 lists some of the features available on erasable drives.

Table 3. Features of WORM Drives

WORM Drives

Vendor	Formatted Capacity Megabytes	Access Time, Millisec	Data Transfer Rate kbit/sec
Advanced Graphics Apps Inc.	800--2,000	108--150	1,200
Cherokee Data Systems	600	135	5,000
FileNet Corp.	160,000+	8,000	2,000
Hitachi America Ltd.	600--2,600	93--250	440-1,500
IBM Corp.	200	230	2,500
Information Storage Inc.	244--2,560	90--135	2,500-6,500
Laser Magnetic Storage	654--2,000	75--150	1,250--1,330
LaserData Inc.	400--1,000	150	300
Laserdrive LTD.	405--810	175	272
Maximum Storage Inc.	244--760	28--135	2,500-5,000
Maxtor Corp.	786	133	1,250
Micro Design International Inc.	420--3,202	65	70--300
Mitsubishi Electronics America	600	70--80	1 500
N/Hance Systems Inc.	244--2,560	75--135	6[illegible]10,000
Optimem	2,000--4,000	150	625--1,250
Pioneer Communications USA	654--1,500	77--250	650--1,500
Shugart Corp.	400	195	2,200
Storage Dimension Inc.	786	108	2,500
Verbatim Corp	6,800	9--700	10,000
Wang Laboratories Inc.	2,000	150	256

Source: Govt Computer News, v8, n4, pp. 62-64, February 20, 1989

Table 4. Features of Erasable Optical Drives

Erasable Optical Drives

Vendor	Formatted Capacity Megabytes	Access Time, Millisec	Data Transfer Rate kbit/sec
Advanced Graphics Apps Inc.	650	61	1,200
Alphatronix Inc.	650	83	7,000
Cannon USA Inc.	512	90	6,600
InSite Peripherals	20.8	65	1,600
Maxtor Corp.	650--1,000	35	10,000
Sony Corp. of America	594--650	95	620--680
Verbatim Corp	60	30	1,500--2,100

Source: Govt Computer News, v8, n4, pp. 62-64, February 20, 1989

3. Image Transmission/Computer

This component of a document filing system can easily be considered the most important. It is with this component that the images previously captured can be accessed by the user. Various factors affect the capability of the total system, some of which are described below.

a. Transmission Speeds

Currently many organizations have utilized local area networks (LAN's) as a method to distribute information throughout an organization. Various LAN topologies offer plusses and minuses which the organization must address when comparing them to

systems that may already be in place. The technicalities of each methodology will not be addressed in this thesis[2].

b. Indexing

Although images may be available on optical disk or some other media, the need to be able to access them in a structured way is necessary. This is accomplished by assigning an index to the image. Individuals often use alphabetical or type indexes when arranging documents. In computerized document filing where hundreds of images may be attributable to one record a more sophisticated scheme is required.

> Indexing is a process which allows us to identify and select the elements, or descriptors necessary to describe a document. In its simplest role, an index is a locating tool for individual documents. In a more complex and important role, it is a consolidating device to bring together documents that are not necessarily stored in the same place, contained in the same medium, or generated by the same entity. [Ref. 7]

There are many factors that affect an indexing scheme. One factor is that it must accurately describe the image. If personnel records are the items stored, using the social security number (SSN) of an individual may be inadequate if there are many records for an individual. While descriptors from a particular record can be used

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[2]For a more detailed description of the various methodologies see reference 6.

for indexing, care must be taken to ensure a minimum number of indexes. Otherwise the indexing procedure may become difficult to use.

Another factor is the rationale behind the indexing scheme. If all records pertaining to an individual are needed, then a simple scheme such as SSN may be sufficient. If only certain files from a record are required then more care must be used to ensure that only the desired ones are retrieved.

If the need for comparing one record to another is necessary, such as invoices to funds received, then still another indexing scheme must be utilized.

Indexing can also affect the usability of the system. If care is not taken to model how or why the records will be accessed then users may find the indexing scheme to be useless.

c. Computers

The computer is the heart of a document filing system. It manages the storage of the image, the indexing system, the transmission of the image, and the display of the image to the user. The configurations available are numerous and varied. The computer processor must be capable of managing thousands of images and possibly many users.

Paper based system users can accept the fact that it may take a records clerk hours to find a particular document, especially if it is not stored locally. However, that same user may become frustrated when a request for a particular file is made through the

computer and it takes 30 seconds. The computer must be capable of providing the file quickly and efficiently. Organizations must determine what is acceptable for their environment and ensure they have the resources to accommodate users.

4. Image Presentation

For an optical document filing system to be effective, the scanned information must be accessible by computer, both visually and physically. Typically, high resolution graphics terminals and laser printers, are used in combination since one without the other is useless.

a. High Resolution Graphics Terminals

These terminals are required in order to visually display captured images. If the system provides capability to scan an image at 300 dpi, but only view it at 75 dpi, the additional storage space required for the higher resolution may be wasted. If only a small portion of the image is viewable, then overhead will result in viewing other portions of the same document. The terminals must show the document as if the users were looking at the paper in their hands so as to resemble more the way individuals use paper.

Document imaging terminals have screens that are larger than normally found on standard video display terminals. The most common monitor size is 19". This feature allows for the image of a standard 8 1/2" x 11" document to be totally visible on the screen as well as additional windows that allow the user to manipulate the image.

b. Laser Printers

Laser printers are used, as opposed to dot matrix or impact printers, because the results are usually as good as the original. In addition, laser printers allow for the reproduction of graphics such as signatures or photographs that are most commonly found in paper files.

C. SUMMARY

Paper continues to be a product of business because it is the easiest way for information to be passed to others, especially if the others do not have a computer. Document filing systems have relegated paper to a data entry medium and is being discarded once it has lost it's immediate effectiveness.

The previous sections have provided an overview of various necessary components in an optical based document imaging system. Each component was not addressed in great detail as this thesis focuses on issues that concern the information manager when applying these systems to their business. The following section addresses issues with which, an information manager must concern himself.

IV. SPECIAL CONCERNS

A. INTRODUCTION

Before automated records management it was a relatively simple task to implement management directives that ensured the completeness of case files. Managers simply made sure that everything that pertained to a certain case was in a folder. In simple cases, putting everything in one manila folder was sufficient to ensure completeness. As files became larger and more interrelated, copies were made to be included in related case folders.

Records management became a little more complicated by using computers and databases. Still, records managers simply had to look at the way their case files were organized to come up with procedures necessary to automate them. Computers allowed managers to quickly collect all the information on a particular case even if the information was maintained in different case files. As databases became larger, more care had to be exercised in designing the database, but access was easier than trying to put together the old paper files.

Computer technology advancements have helped the information manager. Computer processing speeds have increased so much that very large database case files are capable of being retrieved in seconds, vice hours, from the old manila folders. Storage capacities

of the various media have increased, allowing even more information to be stored on line.

The advent of optical imaging has created a number of special concerns for the information manager. The legality of an image stored in an optical memory system to be admissible in court has blurred the vision of the paperless office. Workflow through a business has become more intricate in pursuit of increasing productivity of personnel and reliability of information. Technology has improved rapidly, providing solutions for information management to be many. As a result, users of these systems have found new problems arising. The following sections will look at the issues as they apply to optical imaging systems.

B. LEGAL ISSUES

From a business record perspective a question exists as to the admissibility of an image in place of the original in a court of law. Is it acceptable to take a document, scan it into an image system, and then destroy the original? Before implementation of such a system, an organization must consider the question. At present no conclusive answer has been determined in the legal system. However, there are statutes that indicate that the federal and state judicial systems will adapt to electronic images just as they have adapted to the use of microfilm and computer generated printouts.

1. Federal Rules of Evidence

The law of evidence is the system of rules that regulate the admission of proof in a court of law. In order to admit something as evidence it must be accurate, reliable, and trustworthy. Subsection Six, Rule 803, of the Federal Rules of Evidence states that a document can be entered as evidence if:

> A memorandum, report, record, or data compilation, in any form, of acts, events, conditions, opinions, or diagnoses, made at or near the time by, or from information transmitted by, a person with knowledge, if kept in the course of a regularly conducted business activity, and if it was the regular practice of that business activity to make the memorandum, report, record, or data compilation, all as shown by the testimony of the custodian or other qualified witness, unless the source of information or the method or circumstance of preparation indicate lack of trustworthiness. [Ref. 8]

Federal Rules of Evidence have been successfully used in counteracting two primary bases of challenges; hearsay and the Best Evidence Rule. The hearsay objection is raised when it is not possible to cross examine witnesses about facts being testified to. The Best Evidence Rule states that the original should be entered as evidence unless there is some satisfactory excuse for non-production. Both the hearsay and Best Evidence Rule objections can be applied to all types of documents and therefore are not unique to optical storage. [Ref. 9]

The courts have been very liberal with respect to the admissibility of documentary evidence for three reasons. The first is that more and more documents are being created by one person,

added to by another, and finished by a third. The second reason is that copies are finding more prevalent use as a result of the first reason; not everyone can have the original. The third reason is that it is becoming increasingly difficult to determine the definition of an original. Which copy in the word processor is the original? [Ref. 9]

The hearsay objection can be overcome using the Federal Rules of Evidence by ensuring that the documents being used by business, whether copies or the original, are in fact, good enough for the business. If they are, courts have generally accepted them. The Best Evidence objection can be overcome if the business can show that the copy is an accurate reproduction of the original. This is similar to an individual receiving a notarized copy of a document.

2. Federal Uniform Photographic Copies of Business and Public Records Act (FBRA)

The FBRA states that any business that has kept records in the regular course of doing business and has caused any or all records to be recorded, copied, or reproduced by a process which accurately reproduces the original then the original may be destroyed, unless its retention is required by law.

The FBRA, although not specifically addressing optical images, gives no indication that optical images are not allowable in court. As long as the procedures that were used to create the image are documented and defined, some method exists to check for the accuracy and reliability of the image, and the business can show how

it relied on the image to conduct its activities, the image should be allowed as documentary evidence in a court proceeding. [Ref. 9]

3. Implications

Both the above statutes support the use of optical images as evidence. Computer data compilations have previously been admissible in court; therefore it is reasonable to suspect images, simply another form of data compilation, are also acceptable. However, in order to admit image data compilations, the images must pass through a system that ensures its validity. In general, the image must be: [Ref. 9]

- created and maintained at or near the time of the event in a reliable manner;
- reproduced in the regular course of doing business; and
- adequately reproduced to ensure the reproduction was made from the original

The first condition implies administrative measures must exist to ensure the image is captured in a systematic manner. The scanning and indexing procedures must be described and followed to ensure that what is scanned is in fact the image. Ensuring the procedures are followed provides reliability for the system in terms of the judicial system.

The second condition implies the process of storing images and using them to perform business functions must be the intent of the system. The images must become an integral part of the business. Just as data is gathered and put into some form of report to be analyzed, the images must be shown as also being gathered to

determine some business objective. For example, using information from images in an insurance case file to make some determination on what kind of payment is due.

The final condition is that the image be reproducible in a format that could be identifiable with the original. The use of WORM storage devices satisfy this condition by the simple fact that the document, once entered, is not alterable. The contents on a WORM drive are easily recognizable when high resolution graphics terminal and laser printers are used. When the original is compared to these different methods of output it is easily recognizable.

One last consideration must be addressed: the requirement for the retention of a document must be investigated. If a legal requirement exists for the retention of a document then the destruction of the original may not be allowed. Although the idea of a paperless office may not be achievable, at least the speed of access to documents will be reduced.

For the information manager to ensure all the conditions discussed above are met, appropriate measures have to be developed. The integrity of the data must not become an issue. Ensuring set procedures are followed when scanning, and approved methods for maintaining the integrity and security of the system are implemented, the issue of legality is no longer debatable.

C. WORKFLOW

Information is a vital resource to any organization. The need for information in today's competitive world has resulted in more information being stored and manipulated by computers. However, studies have indicated that only one percent of an organization's total information is stored on-line. Paper accounts for 95 percent of information exchange. Other studies have found startling statistics on how paper is used: [Ref. 10]

- A business document is photocopied 19 times
- The average executive stores the equivalent of five filing cabinets of paper
- 318 billion paper documents are on file in the U.S.

The above statistics force the information manager to look at the way his organization stores and, more importantly, uses information. Although optical storage technologies allow for more information to be readily available, the idea of storing 318 billion pieces of paper is unthinkable.

When implementing a document imaging system, control of paper must be emphasized. Simply scanning every piece of paper must be thoroughly examined for its necessity and relevance. Not storing the proper documents is equally detrimental to the organization.

As stated previously, the legal issues force the information manager to establish procedures to ensure the validity of an optical system. This requirement is especially critical when the original is destroyed. Before imaging systems, information was extracted from

a document, keyed into a database or some other application, and the document filed away. If a question arose on the validity of the computer information the document could be located and compared to it. Although the document may have been difficult to locate it was still possible.

In today's business activities very few documents are worked on entirely by one individual. Many people may get involved in processing a simple case. This is demonstrated by an insurance claim. An adjuster may receive some documents supporting the claim of an individual. The adjuster verifies documents and sends them to the payment branch. The payment branch verifies the identity of the claimant and sends out a check.

Optical images allow for an image to flow through the system to be acted on by different people. If a question arises, any one person can locate the image in the system. Images do not become unavailable because they are checked out to someone else. Productivity of personnel will increase as well as satisfaction to customers who no longer hear their file is unavailable.

One aspect of business that is affected is the quantity of paper necessary to conduct business. The optical system will require business activities to evaluate the size of their files. Unimportant documents must be identified to ensure they are not included in an image system. Documents will no longer be needed in multiple locations because there is always the image in a central repository. Business files will likely decrease in size as a result of imaging. The

concept of workflow is not simply a matter of automating a manual system but ensuring that the information is available to support the business.

1. Information Paths

To ensure an imaging system accomplishes the organizational objectives a systematic decision making process must be utilized to evaluate workflow. That process should: [Ref. 7]

- Identify structured tasks in an organization and the level of performance in a system to meet them;
- Recognize the potentials and limitations of the technologies to meet the objectives;
- Determine which tasks are cost effective and which are not; and
- Establish interfaces between the structured and non-structured tasks in the imaging system.

Document imaging systems require examining the flow of information in an organization. Documents provide the necessary information to users in performing their business duties. Determining the critical path of the documents will provide the initial requirements of a document imaging system.

There are essentially two channels that comprise the critical path: formal and informal. Formal paths can be identified by examining the path of documents in the current system. How the document arrives in the organization, who determines where it will initially go, and the action performed on it once it reaches various users. Whether a document stops being processed by one individual or needs to go to other departments is readily ascertained. [Ref. 7]

Informal paths are more difficult to determine. They may be paths that are helping an otherwise unacceptable flow to be workable. For example, an individual calls another department to get more information for a document instead of sending the document in the mail. Informal paths must be recognized and considered when determining the flow of information.

2. Retrieval Patterns

Retrieval patterns of documents must be investigated since they impact user job performance and system acceptability. The retrieval pattern determines the indexing necessary, file size, response time, and security issues. [Ref. 7]

Study may show that only one document is used to perform some action. In this situation a simple indexing method could be used to allow direct access. If more than one document is required, such as can be found in a folder, then indexing must ensure all pertinent documents are retrieved. Indexing is especially important if one folder comprises hundreds of documents. The user would be required to page through each image trying to locate the ones needed. The ability to mark one page while looking for others will not be possible. Most users will be unable to remember what was on page 43 of a one hundred page record. [Ref. 2]

The retrieval paths will indicate which documents are accessed more frequently. The age of the documents in a case file may show that the older ones are not accessed frequently and action is done primarily on the most recent. These paths will determine an

indexing strategy that ensures the most recent documents are available first.

Paths will provide initial security requirements for the system. They will indicate if users are requiring documents for information or if more information is to be appended. The latter is illustrated by an insurance adjuster who reviews a case when a customer calls to determine which forms have been received and if any others are required. Retrieval patterns will show who is authorized to access and change files.

Bottlenecks in the paths can be determined. Documents which are used by an individual and remain in his work area for extended periods of time provide insight into potential problem areas of an imaging application. Investigation into the causes of the bottlenecks will ensure the retrieval paths do not become congested.

Paths will determine the response rate of the system. If large files are required, the ability of the system to provide documents quickly will have to be ensured. Examination of the amount of time each file is needed will determine the transfer requirements of the system. The ability to provide documents to users in a timely manner will have a direct impact on the success of the system. Although lengthy retrieval times of paper files from a storage site may be tolerable, undue delay in an automated system will cause the system to be unacceptable. This is especially evident if users perceived the system would allow them to do their jobs quicker.

D. THE FILES

The goal of a document imaging system should not be to eliminate paper, rather it should be to better utilize information. Organizations use paper files in varying degrees. The goal of the information manager is to recognize how the paper is used and ensure that the imaging system performs at least at the same level. Factors such as the volume and conversion needs will dictate how the image system will be configured.

1. Volume

Records management studies determine the volume of paper in an organization. How much paper is received every day determines how frequently images must be entered into the system. Capacity of the input devices and number of available personnel must be adequate or else users will perceive the system as unresponsive.

Volume affects the ability of image systems to retrieve documents. Unnecessary storage of documents has an impact on hardware costs as well as costs not as easily identifiable, such as productivity. As volume of material increases, average search time increases and response time deteriorates. [Ref. 7]

Volume requirements will dictate system configuration. Access to many documents may be a requirement. The access requirements must be thoroughly examined to ensure volume does not affect the user's ability to retrieve documents. Jukebox systems

are capable of storing a large volume but examination of access requirements may show that requests are delayed because of the many disk changes required to obtain all documents.

Multiple disk changes are minimized by storing related documents on the same disk and speeds up retrievals. This requires examining growth rates of files and implementing storage criteria that ensures disks contain complete files. Periodic review of stored images and restructuring disks will need to be considered much like optimizing a hard disk when it becomes fragmented.

2. Document Base

A determination must be made as to the point in time when the imaging system takes over filing functions. Determining which documents need to be included in the image system assists in determining the start point. One methodology includes all relevant past documents, the other chooses a particular time to start.

The first method allows the indexing scheme to represent all documents. Documents can be examined and indexing can ensure all documents are properly described. This helps the user ensure all documents necessary for action are available. The disadvantage is that the volume may require a capacity that is not affordable or would require added unacceptable conversion costs. Another disadvantage is the indexing scheme may become difficult to use because of its attempt to describe all documents. Retrieval may not be user friendly because of increased levels of indexing required to describe documents.

The second method, called "day-one", has the advantage of ensuring that the most recent documents are available. Indexing would only have to consider documents that are currently used or recently received. Conversion costs would be minimal because older documents are not required. The disadvantage is that for some period of time users may have to use two systems. If at some point older documents are needed, the indexing scheme may not be flexible enough to access them. Required access to older related documents that are not available, creates problems in user acceptability. [Ref. 7]

The organization must determine how images will be incorporated. Combining the two methods may provide acceptable results. By examining retrieval patterns, old documents can be identified that need to be included in the day-one approach. This approach allows the user to obtain documents that are necessary and ensures system acceptability.

3. Information

Document imaging systems provide no more information than do database reports from an automated system. In fact, reports may be capable of providing more concise information than an imaging system. This aspect must be recognized by information managers. Although documents can be viewed and, as a result, information observed, the text on the image is not independently retrievable. Only information captured during indexing is capable of being gathered into report formats.

Chapter III described the process by which documents are converted to digital information. Text and graphics are recorded as pixels. Individual pixels do not represent independent words, rather they represent the black and white levels on a document. Once documents have been scanned they cannot be searched for certain black and white areas.

Information managers must realize that document imaging systems will not take the place of current database systems. Rather, they will allow for better utilization of paper files. For example, personnel files that contain documents concerning an individual's performance. Performance will be documented in free format and will vary according to who wrote the evaluation. An imaging system would allow the retrieval of performance sheets and either print or view them. It would be very unlikely that such documents would be required based on certain words.

To ensure success of an imaging project the concept of image individuality must be carefully conveyed to users. Proper conveyance will ensure the indexing system describes the way users will use the imaging system.

E. TECHNOLOGY

Chapter III described various components that comprise an imaging system. Optical technology is relatively new, therefore a number of factors must be considered.

Lack of format standards among optical equipment vendors must be recognized. An organization that elects optical imaging must be sure that the system will be supported in the future. Scanning thousands of pieces of paper to images can be costly. To do it again because new equipment is obtained which is not compatible is not desirable.

Changes in volume of documents that are maintained on-line must also be considered. The growth rate of files must be examined to ensure added volume will be accommodated Vendors must be identified which can support system growth. Agreement on format standards would alleviate the problem, but currently this is an issue information managers must address.

Computer capacity of an organization may not be capable of supporting the additional requirements of an imaging system. Using stand-alone systems allows an organization to explore imaging solutions without disrupting current applications. The disadvantage is that stand-alone systems may not be compatible with current database systems. Two systems maintained concurrently may cause user acceptance problems.

The data transfer rates of LAN's cause problems. Currently LAN's do not support the bandwidth that is required to transfer images across a network quickly. Vendors may say that they utilize an Ethernet or Token ring network but careful examination as to how the images are handled must be examined [Ref. 11]. Figure 3 illustrates the time required to transfer a 100 Kb file with various

transfer rates. Figure 4 illustrates other factors that affect retrieval times of optical systems.

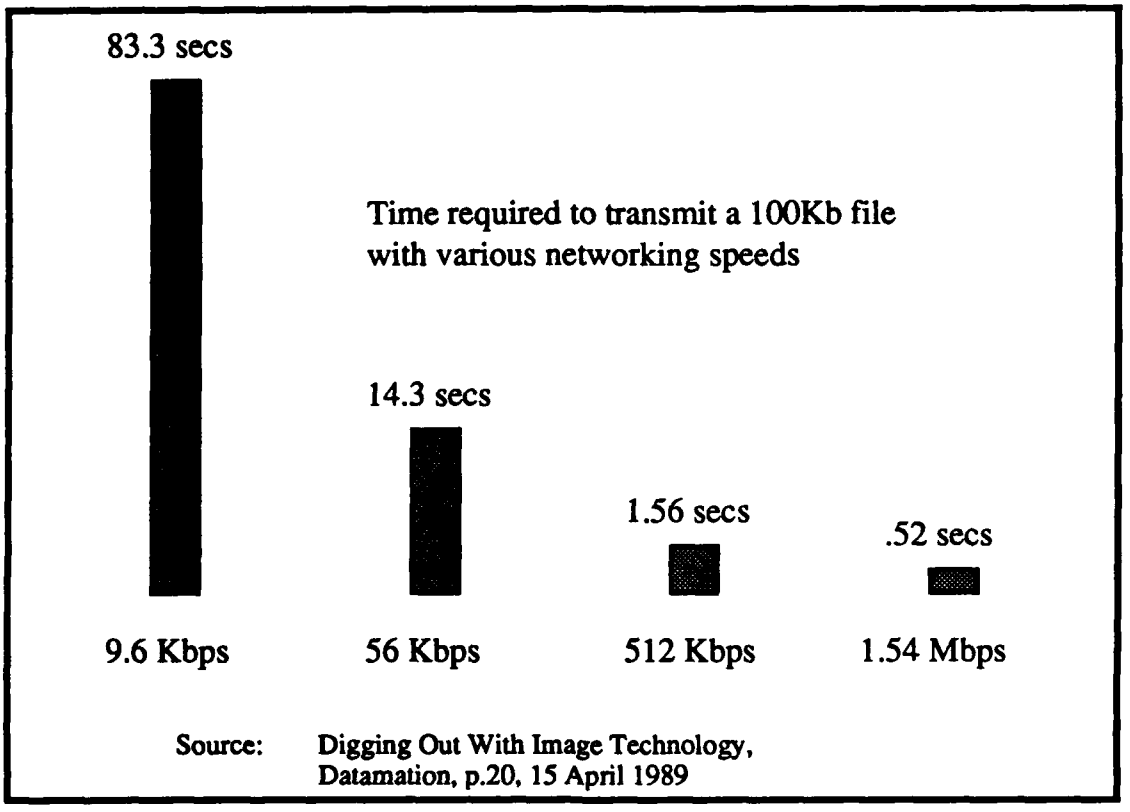
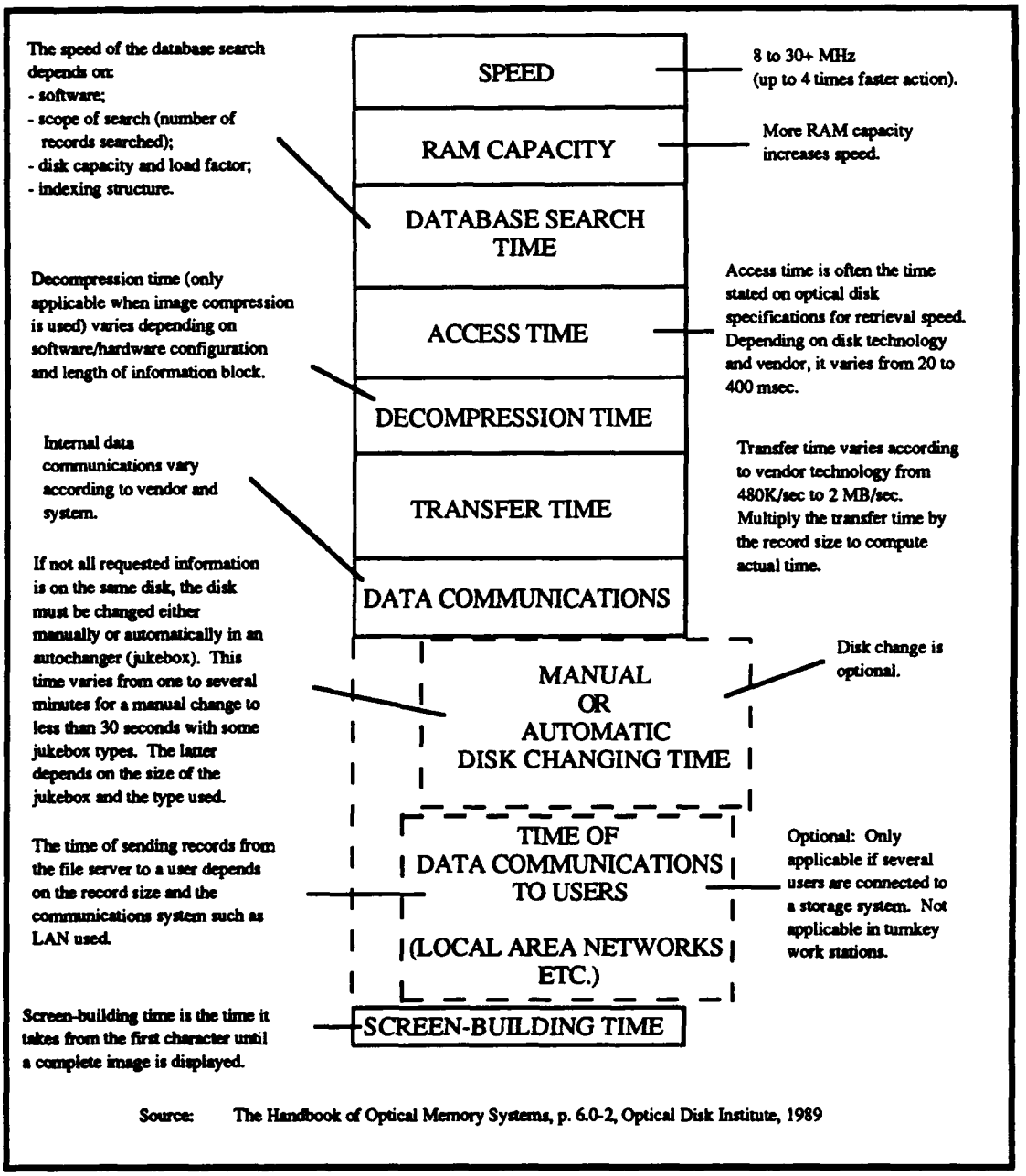


Figure 3. Transfer Speeds


The speed of the database search depends on:
- software;
- scope of search (number of records searched);
- disk capacity and load factor;
- indexing structure.
SPEED
8 to 30+ MHz (up to 4 times faster action).
RAM CAPACITY
More RAM capacity increases speed.
DATABASE SEARCH TIME
Decompression time (only applicable when image compression is used) varies depending on software/hardware configuration and length of information block.
ACCESS TIME
Access time is often the time stated on optical disk specifications for retrieval speed. Depending on disk technology and vendor, it varies from 20 to 400 msec.
DECOMPRESSION TIME
Internal data communications vary according to vendor and system.
TRANSFER TIME
Transfer time varies according to vendor technology from 480K/sec to 2 MB/sec. Multiply the transfer time by the record size to compute actual time.
DATA COMMUNICATIONS
If not all requested information is on the same disk, the disk must be changed either manually or automatically in an autochanger (jukebox). This time varies from one to several minutes for a manual change to less than 30 seconds with some jukebox types. The latter depends on the size of the jukebox and the type used.
MANUAL OR AUTOMATIC DISK CHANGING TIME
Disk change is optional.
The time of sending records from the file server to a user depends on the record size and the communications system such as LAN used.
TIME OF DATA COMMUNICATIONS TO USERS (LOCAL AREA NETWORKS ETC.)
Optional: Only applicable if several users are connected to a storage system. Not applicable in turnkey work stations.
Screen-building time is the time it takes from the first character until a complete image is displayed.
SCREEN-BUILDING TIME

Source: The Handbook of Optical Memory Systems, p. 6.0-2, Optical Disk Institute, 1989

Figure 4. Retrieval Time Factors

V. SERVICE RECORD APPLICATION

A. INTRODUCTION

The United States Coast Guard is a military organization considering using optical imaging systems to maintain personnel records. The Coast Guard maintains records to document the history of service of individuals. Records are maintained for as long as an individual is on active duty which can be in excess of thirty years. Records continue to be maintained when the individual retires or transfers to the USCG Reserve.

The Office of Personnel (G-P) is tasked with maintaining service records. There are approximately 5500 officer records and 32,000 enlisted records. Service records are maintained by file clerks who file and retrieve documents as required.

An automated system, separate from the paper service records, is used to track various personnel actions. The system is a Harris 800 minicomputer with 100 asynchronous terminals connected in an Ethernet LAN. COBOL programs run all but the simplest queries. Applications provide assignment officers (Detailers) with current assignment as well as desired assignment information to assist in making assignment decisions. Generating transfer orders and forecasts of permanent change of station (PCS) costs are possible. The Enlisted Evaluation database is also maintained.

The system provides support to the Officer Status and Enlisted Career Branch for the following:

- Printing of the Officer Register;
- Tracking of signal numbers; and
- Forecasting of zones for promotion/advancement.

The Harris system is no longer supported. A Sequent S81 super minicomputer with 12 processors running the UNIX operating system has replaced the Harris. The multiple processors will handle network communications, applications, and database control. The database management system (DBMS) is Oracle. Conversion from the Harris COBOL programs to Oracle is currently in progress.

All functions previously provided will be available with additional functions provided in the following areas:

- Workforce Planning - Will provide the ability to predict personnel impacts of various policy decisions by forecasting force inventories, personnel accession goals and training requirements based on projected operational missions, resource allocations, budget and historical data.
- Automated Service Record Database Access - Will provide access to service record information to individuals that do not have access through some other application.
- Service Record Imaging - Will provide access to digitized documents from an individual's service record.
- Enlisted Personnel Status - Provide applications for advancements, separations, retirements, and discharge review boards. All are currently done manually.
- Miscellaneous applications for Retired and Decedent Affairs, Coast Guard Housing Management, Family Programs, Physical Disabilities Evaluation Boards, and the Medals and Awards program.

Coast Guard Standard Workstations will provide the office automation functions and the user interface to the database engine. Approximately 250 workstations in 17 clusters will be connected via an Ethernet backbone to the Sequent.

The Service Record Imaging Application is the focus of this chapter. This function will require additional analysis (beyond the scope of this thesis), hardware, and software before the Coast Guard can implement an imaging application.

B. THE SERVICE RECORD

The military service record is the source of data concerning an individual's service history. Officer and Enlisted records contain similar documents but, for purposes of this thesis, emphasis will be placed on the Officer service record. Documents include the Officer Evaluation Report (OER) which documents the performance of an officer. This document is the primary source for determining assignments, promotions, and retention. Additional documents such as citations, education reports and miscellaneous letters are retained.

Service records are stored on shelves from ceiling to floor. Individuals that want to read their record are required to provide their military identification card and sign a log. A file clerk retrieves the record and remains in the room with the individual to ensure documents are not removed or added. Similar procedures are required for Detailers to review a record.

An instruction has been promulgated that will streamline the service record. The record is now called the Military Personnel Data Record (PDR) and requires, where possible, no document be stored in more than two locations. Prior to this instruction the service record was maintained in at least four locations with no controls for redundancy. Records were maintained at Headquarters, at the Personnel Reporting Unit (PERSRU), at the unit, and by the individual. It was a very time-consuming process to validate the information in each of these records and for the most part was not done. [Ref. 12]

A study of the Headquarters service records showed [Ref. 12]:

- Personnel Management Information Support (PMIS) documents accounted for 33 percent of all documents filed. PMIS documents are used to support various personnel actions such as starting and stopping allowances, reporting times and accounting data for various actions during a permanent change of station. Distribution required that a copy be sent to Headquarters and, once received, were indiscriminately filed. Headquarters performs no action on PMIS documents other than filing.
- Miscellaneous documents, never required to be distributed to Headquarters, made up an additional 32 percent of the record. These documents were short-lived and were never meant to be kept for the life of the service record. An arbitrary decision was made to send them to Headquarters. Due to the unstructured system they were simply filed.
- Health documents made up an additional 20 percent. These were a result of being mistakenly forwarded to Headquarters (G-P) instead of the Office of Health and Safety (G-K).
- The remaining 15 percent were necessary.

The instruction provides direction on which documents should be filed and where. Although four files are still required to be maintained (Headquarters PDR, PERSRU PDR, Unit PDR, and Member

PDR), no document is required in more than two places. Requirement for more than one record is necessary to ensure a record can be reconstructed. Prior to any imaging applications the Headquarters PDRs must be reviewed for compliance. The basis of an imaging system should be the streamlined PDR.

1. Headquarters PDR

Headquarters PDRs consist of two folders. The first is designated the General File. It contains four sections: Accession and Separation, Career Documentation, Reports, and Boards. The second folder is the Performance File which also contains four sections: Summary Sheet, Performance Evaluations, Awards (personal) and Discipline, and Training and Education. Appendix A lists the documents required and which section they are filed.

C. THE USES

The Headquarters PDR will be the focus of this section with particular attention given to officer records since the officer corps is smaller and potential problems of an optical imaging system may be easier to evaluate.

Many decisions are made from information in PDRs. Officer Promotion Boards review PDRs of individuals in the promotion zone for advancement. Selection Boards review individual's PDRs for assignment to Commanding Officer afloat positions, Postgraduate Training, Physical Evaluation, Correction of Military Records, Administrative Discharge and Personnel Record Review Boards.

Every portion of the record is reviewed with particular attention to the Officer Evaluation Report (OER).

The utilization of an imaging system would allow access to PDRs that currently require a request to the files section. The primary recipients would be Detailers and Boards. Productivity enhancements for the two users would be the primary basis for attempting an imaging solution. An additional benefit would be evident to the file section when preparing the records for Boards and in answering queries from individuals concerning the contents of their record.

Another benefit is of providing a backup of the paper records. Although paper backups do exist as a result of the PDR instruction, OER documents are not required in two places. When the OER is reviewed at Headquarters, a copy is made and returned to the individual to verify the records branch has the OER on file. The Headquarters copy is the official copy and the individual is not required to retain his receipt copy. If the Headquarters copies were destroyed, the only way to reconstruct the history of OERs would be to obtain them from the members, provided of course they kept them.

D. MANAGEMENT PLAN

This section is intended to provide an outline of special concerns as they apply to an optical image system of the Headquarters PDR. These concerns should be measured against a complete requirements

analysis that would be conducted prior to developing a system. The Management Plan is not an attempt to conduct a requirements analysis, but to address the issues presented in the previous chapter.

1. Legal Concerns

Chapter IV determined optical images would be legally admissible in court as long as procedures were properly implemented. The requirement of destroying the original should be a part of business practices.

Coast Guard legal experts need to determine if any basis exists for maintaining paper files. Examination of past cases which utilized PDR documents would determine if images would have been sufficient. It may be prudent to test image acceptability in an actual case prior to any destructions. Successful cases would justify destruction.

Legal requirements exist to transfer an individuals PDR to the National Personnel Records Center (NPRC) upon separation or to the Coast Guard Office of Reserve (G-RSM) upon transferring to the Reserves. Systems at NPRC and G-RSM do not support imaging, therefore retention of paper records may be desirable.

If paper destruction is a requirement then procedures could be implemented so that when it is necessary to transfer the PDR a printed copy of the PDR would be made on a laser printer and sent to the required location. If the individual returns to active duty, simply locating his archived file on optical disk would allow recreating the active record.

2. Workflow

Information paths and retrieval patterns of various documents in the PDR will determine the possible scope of an imaging application. Each document has to be examined to determine who needs to see it. In addition, a determination as to whether it even needs to be included in the image database needs to be made.

The restructuring of the paper PDR system has begun the process of determining which documents are necessary in the Headquarters PDR. Further investigation would have to be conducted to determine if documents require additional processing after receipt. For example, OERs are reviewed by Detailers to ensure marks assigned reflect the written comments. If they do not, the OER is sent back to the preparer with instructions to correct the comments or adjust the marks. The frequency of returning an OER for revisions would require defining procedures for tracking OERs awaiting revision.

Further investigation is necessary on how various Boards utilize the PDR when conducting reviews. Are all documents reviewed or only certain ones? Are some documents more important than others? Does the age of a document affect its importance? Currently, when a Board is convened a request is made to the files section to collect the records of individuals being reviewed. The PDRs are delivered to a special room devoted strictly for Boards.

Upon conclusion of the Board the records are returned to the file area.

During the time a record is in a Board it is not available to others in the organization. Examination of the frequency a file is requested, but unavailable, may support justification of an imaging application. Additionally, system configuration may be affected. Analysis may show availability of a record is required even when it is in use by Boards. Intense access requirements during Boards may dictate Boards receive images that have been generated on disks specifically for Board use. This would allow the PDR to be available to other users but not affect the Board's work or system response to users outside the Board.

3. The Files

The Coast Guard has begun the task of streamlining the PDR as described previously. Documents have been identified which will require retention in the paper system. These documents will provide the basis on which an imaging application can be implemented.

The number of documents in each file has yet to be addressed. Further study will be required to determine the volume of paper that will be converted to images. If volume is great then further study will determine if only a portion of the records be imaged.

For purposes of this thesis only OERs will be examined since they constitute the major source of information. However, similar examination would be required of the other documents in the PDR.

OERs are stored in the Performance file of the PDR. In the past ten years no less than four different OER forms have been used. The forms have been designed for use in a paper environment. They are printed on both sides with the back upside down. The purpose is two-fold: reduce the amount of paper and allow for easier reading when flipping the pages since they are fastened at the top.

OERs are submitted semi-annually for Lieutenant (LT) and below and annually for Lieutenant Commander (LCDR) and above. This is a recent change in the last two years. Prior to the change they were required semi-annually for all members. The present forms consist of four pre-printed pages with space for comments to be written by supervisors and reporting officers.

There are slight variations to the semi-annually reporting requirement. Reports are required upon transfer of the Reported-on officer and transfer of the Reporting officer. Although the semi-annual reporting requirement is variable the average remains semi-annually. Problems arise when requesting a specific OER. The user may not be able to locate a record by date since it is possible the date of submission is different from the normal reporting times as described above.

Indexing schemes will have to be implemented that allow access to particular records with minimum of effort. If users have to look at the entire file of OERs then a simple scheme developed using social security numbers may suffice. The entire record would be available, allowing for paging through to the desired report.

However, individuals that have been in the service for some time will have many OERs. A LT with ten years of service would have a minimum of 20 four-page OERs. Flipping through 80 pages to locate a specific one is undesirable.

The indexing method used must represent the way users will be retrieving the images. The way information is required will dictate the indexing system. As discussed earlier, only information that has been captured during indexing is capable of being used for retrieval purposes.

The imaging system would not be capable of providing summary information on written comments on the OER unless key words were used when indexing. The use of key words is not recommended since not all OERs contain the same words even if they describe the performance of individuals performing the same job.

Determining the point in time that the image system will begin will assist in determining the document base. If all Boards will use the imaging system then converting all files will be required. Deciding that only certain Boards will use the imaging system would reflect a day-one approach. An example would be promotion Boards for Lieutenant Junior Grades (LTJG). This approach would limit the size of the image database and would provide time to test system performance and acceptability before major conversion costs are incurred.

4. Technology

Imaging system procedures would be necessary to collect all the records necessary for a Board. Examination of Board practices would be needed to determine how quickly a file is required. If the imaging system does not provide reasonable access speed then Boards may spend an excessive amount of time waiting for images to be displayed.

The large size of images and the access times of optical drives may cause waiting times to be excessive. Conducting reviews of several Boards and determining how much storage space is required for all the images may indicate images be downloaded to a large capacity Winchester drive specifically for Boards to ensure speed.

The Coast Guard Standard Workstation is the system that most Coast Guard personnel are familiar with. Presently the components of the imaging system are not available on the Standard Workstation contract. Hardware would have to be identified that could be utilized in a Standard Workstation cluster, provided of course the cluster would be the method of transferal images through the organization.

Not all clusters will require high resolution terminals. In order to ensure transfer speeds are not affected, clusters that require access to PDRs would have to be identified. The use of stand-alone systems may alleviate the problem of Standard Workstation compatibility but would require the use of two systems.

The volume and document base will drive the capacity of the imaging system. Hardware selected must be capable of supporting future growth as the image database increases. The day-one approach must carefully consider the ability of the system to support the images required as the application grows.

E. SUMMARY

The issues described in this section point out problems that should be addressed when considering optical imaging systems. Only one set of documents were examined for potential use in a Coast Guard system. More detailed study of workflow and information requirements from documents in PDRs will further flesh out potential applications.

More detailed analysis is required on the technology side. The Sequent, Standard Workstations, and imaging equipment must all be integrated. This can only be accomplished by conducting formal requirements analysis and soliciting information from vendors of imaging equipment.

VI. CONCLUSIONS

The use of optical technology for information management is on the horizon. Some information managers have recognized the potential benefits of instant retrieval of documents, increased reliability on the completeness of files and increased productivity of users. Some managers have recognized these benefits as ways to increase their competitive advantage.

To ensure that organizations utilize optical imaging most effectively, a cadre of informed Information Systems (IS) staff and users must be cultivated. The relative newness of optical technology in information management has created problems. IS staffs must learn as much as they can prior to engaging in developments. The reasons are the same as with any new technology. Individuals that are informed about optical technology will have a greater probability of integrating optical into an organization.

Staffs can increase their knowledge by attending trade shows, requesting vendors to demonstrate systems, and probably most important, visit organizations that have implemented optical technology in records management.

Obtaining a small system to experiment with is a way to increase the knowledge of users. Indexing strategies can be explored as well as image management techniques. The flexibility of the imaging application, or lack thereof, can be identified. Experiments can be conducted with integrating current hardware and databases with the

optical system. Although only the advantages and disadvantages of the particular system may be identified, this will go far in furthering the education of users.

Optical technology is relatively expensive in comparison to current computer technology. Costs are sure to come down as more organizations experiment and implement systems. To ensure that excessive funds are not spent on projects that fail, IS managers should explore the development of a prototype.

Careful consideration on what aspect of the organization to prototype is important to the success of implementing imaging technology. Choosing an application that is too large increases the interfacing requirements throughout the organization. Choosing too small an application may not sufficiently describe all problems that could be encountered.

Organizations must proceed carefully with optical technology but nonetheless need to explore it. Organizations can begin by examining their current information paths and learning as much as possible about optical imaging applications.

APPENDIX A

The documents required to be maintained in the Headquarters PDR are listed below:

A. HEADQUARTERS PDR

General File	Performance File
Accession and Separation	Summary Sheet
Career Documentation	Performance Evaluations
Reports	Awards (personal) and Discipline
Boards	Training and Education

General File

Section 1: Accession and Separation

Form Number	Form Name
----------	Active Duty Agreements
----------	Separation Orders
----------	Recall Orders
----------	Letters of integration/extension
----------	Letters denoting obligated service
CG-2211	OCS Agreement
CG-3301	Enlistment Contract - USCG & USCGR
CG-3301B	Agreement to Extend Enlistment
CG-3301C	Discharge & Reenlistment Contract
CG-4916	Initial Active Duty Form
CG-9556	Acceptance & Oath of Office
DD-4	Enlistment/Reenlistment Document
DD-214	Certification of Release or Discharge from Active Duty
DD-215	Corrections to DD-214

Section 2: Career Documentation

Form Number	Form Name
----------	Privacy Act Log
----------	Letters of Non-Selection
----------	Letters of Removal for Cause
----------	Letters of Appointment
----------	Officer Promotion Authorization
----------	List
CG-3307	Letters of Indebtedness
CG-4113	Administrative declining advancement/appointment
VA 29-8286	Record of Emergency Data
	SGLI Election

Section 3: Reports

Form Number	Form Name
----------	Reports of Investigation
CG-3822	Injury Reports

Section 4: Boards

Form Number	Form Name
----------	Administrative Discharge Boards
----------	Board for Correction of Military Records

----------	Personnel Record Review Boards
----------	Medical Boards
	Physical Evaluation Boards

Performance File

Section 1: Summary Sheet

Section 2: Performance Evaluations

Form Number	Form Name
CG-3307	Administrative Remarks (performance only)
CG-4328	Officer Fitness Report
CG-5310	Officer Evaluation Report - CAPT
CG-5311	Officer Evaluation Report - CDR
CG-5312	Officer Evaluation Report - LCDR
CG-5313	Officer Evaluation Report - LT
CG-5314	Officer Evaluation Report - LTJG
CG-5315	Officer Evaluation Report - ENS
CG-5316	Officer Evaluation Report - CWO
CG-5311	Officer Evaluation Report (OER) - Level I (Revised 12/88)
CG-5312	Officer Evaluation Report (OER) - Level II (Revised 12/88)
CG-5313	Officer Evaluation Report (OER) - CAPT (Revised 12/88)

Section 3: Awards (personal) & Discipline

Form Number	Form Name
----------	Reports of Civil Arrest
----------	Punitive Letters
----------	Award Citation (copy)
CG-2842	Notification of Removal of Absentee
CG-3304	Wanted by the Armed Forces Court Memorandum
CG-3307	Administrative Remarks (discipline only)
DD-553	Deserter/Absentee Wanted by the Armed Forces

Section 4: Training and Education

Form Number	Form Name
----------	GED Results
----------	Educational Transcripts
CG-3303	Achievement Sheet
CG-4082	Officer Education Record

APPENDIX B

The following list of vendors responded to a request for information on the products that they provide. No specific mention was made during this request as to how their systems would be used in an application. The information received was general in nature and did not list prices.

Vendor	Product
FileNet Corporation 100 First Plaza, Suite 1600 San Francisco, CA 94105	Various turnkey systems which support scanners, printers, jukeboxes, terminals. Uses FileNet equipment.
Aquidneck Systems Intl. 600 Ten Rod Road North Kingstown, RI 02852	Primarily archiving solution using WORM drives.
Discorp 290 Easy Streert #5 Simi VAlley, CA 93065	Systems integrators of DOS based systems including terminals, scanners, printers, WORM drives.
Document Technologies Inc. 2465 E. Bayshore Rd Palo Alto, CA 94303	Systems integrators of image servers, terminals, WORM drives, optical jukeboxes, printers, scanners.
Candi Technology Inc. 2354 Calle Del Mundo Santa Clara, CA 95054	Systems integrators providing their own image server running UNIX. Capable of interfacing with various peripherals.

LaserData 300 Vesper Park Tyngsboro, MA 01879	Systems integrators of DOS based system providing turnkey document image systems.
Imnet 34 MAple Ave Pine Brook, NJ 07058	Microfilm storage and retrieval systems.
Cimage Corp. 23422 Mill Creek Dr. Laguna Hills, CA 92653	Systems integrators primarily of engineering related applications.
Xionics 765 The City Drive, Suite 340 Orange, CA 92668	Systems integrators of optical disk software.
Plasmon Data Systems 99 West Tasman Drive San Jose, CA 95134	Manufacturer of optical disk drives.
TAB Products Co. P.O. Box 10269 Palo Alto, CA 94303	Turnkey optical filing systems.

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